

WHAT IS CLAIMED IS:

- 1 1. A method for producing a hard carbon film on a polymeric
2 surface, the method comprising:
 - 3 (a) exposing the surface to a plasma comprising one or more SF_x
4 species where *x* may range from 1 to 5; and
 - 5 (b) converting the polymeric surface into a film comprising at least
6 about 90 atomic percent carbon.
- 1 2. The method of claim 1, wherein the polymeric surface
2 comprises carbon, oxygen and hydrogen atoms.
- 1 3. The method of claim 1, wherein the polymeric surface is
2 oxidized.
- 1 4. The method of Claim 1, wherein the polymeric surface is
2 converted into a film comprising at least about 95 atomic percent carbon.
- 1 5. The method of Claim 1, wherein the surface is exposed to the
2 plasma at a pressure from about 50 to 500 mTorr.
- 1 6. The method of Claim 1, wherein the surface is exposed to the
2 plasma at a temperature from about 20 to 100°C.
- 1 7. The method of Claim 1, wherein the surface is exposed to the
2 plasma for no more than about 10 minutes.
- 1 8. The method of Claim 1, wherein the polymeric surface
2 comprises a polymer selected from the group consisting of poly(acrylic acid),
3 poly(methyl methacrylate) and polycarbonate.

1 9. The method of Claim 1, wherein the polymeric surface
2 comprises a polymer selected from the group consisting of polyethylene,
3 polypropylene and polystyrene.

1 10. The method of Claim 1, wherein the polymeric surface is
2 comprised of a polymeric layer disposed on an underlying substrate.

1 11. The method of Claim 10, wherein the polymeric layer
2 comprises poly(acrylic acid).

1 12. The method of Claim 1, wherein the polymeric surface is
2 exposed to the plasma for a time sufficient to produce a film comprising no more than
3 about 5 atomic percent oxygen.

1 13. The method of Claim 1, wherein the polymeric surface is
2 exposed to the plasma for a time sufficient to produce a film comprising no more than
3 about 1 atomic percent hydrogen.

1 14. The method of Claim 1, wherein the exposure of the polymeric
2 surface to the plasma produces a film comprising no more than about 1 atomic percent
3 fluorine.

1 15. The method of Claim 1, wherein the plasma is substantially
2 free of oxygen.

1 16. The method of Claim 1, wherein the plasma is substantially
2 free of hydrocarbon precursors.

1 17. The method of Claim 1, wherein the polymeric surface is
2 exposed to the plasma for a time sufficient to produce a film having a thickness from
3 about 0.5 to 5 microns.

1 18. A surface-modified substrate comprising:

2 (a) a substrate; and

3 (b) a surface film comprising a cross-linked network of carbon
4 chains disposed on the substrate, wherein the surface film comprises at least 90
5 atomic percent carbon.

1 19. The surface modified substrate of Claim 18, wherein the
2 surface film comprises a polymer from which hydrogen atoms, oxygen atoms, or a
3 combination of hydrogen and oxygen atoms have been extracted.

1 20. The surface-modified substrate of Claim 18, wherein the
2 substrate is a polymeric substrate and the surface film is integrated into the polymeric
3 substrate.

1 21. The surface-modified substrate of Claim 18, wherein the
2 surface film comprises at least about 95 atomic percent carbon.

1 22. The surface-modified substrate of Claim 18, wherein the
2 surface film has a thickness from about 0.5 to 5 microns.

1 23. The surface-modified substrate of Claim 18, wherein the
2 surface film has a hardness of at least about 950 kg/mm² as measured by Knoop
3 microhardness at a load of 25 grams.

1 24. The surface-modified substrate of Claim 18, wherein the
2 surface film has a hardness of at least about 1300 kg/mm² as measured by Knoop
3 microhardness at a load of 5 grams.

1 25. The surface-modified substrate of Claim 18, wherein the
2 surface film has a Mohs hardness of at least 9 as determined by a fretting wear test
3 using a ruby ball.

1 26. The surface-modified substrate of Claim 18, wherein the
2 surface film has a friction of no more than about 22% relative to hardened steel as
3 measured by a fretting wear test.

1 27. The surface-modified substrate of Claim 18, wherein the
2 substrate comprises a polymer selected from the group consisting of poly(acrylic
3 acid), poly(methyl methacrylate) and polycarbonate.

1 28. The surface-modified substrate of Claim 18, wherein the
2 substrate comprises a polymer selected from the group consisting of polystyrene,
3 polyethylene and polypropylene.

1 29. The surface-modified substrate of Claim 18, wherein the
2 surface film comprises no more than about 5 atomic percent oxygen.

1 30. The surface-modified substrate of Claim 18, wherein the
2 surface film comprises no more than about 1 atomic percent hydrogen.

1 31. The surface-modified substrate of Claim 18, wherein the
2 surface film comprises no more than about 1 atomic percent fluorine.